# THE REACTION OF DATANA LARVÆ TO SOUNDS.

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A considerable amount of discussion has been devoted to the possibility of the presence of an auditory sense in insects. Unfortunately, much of this discussion has been purely theoretical. At one time it was generally supposed that all or most insects could hear. This argument was based upon two facts: the possession, by insects, of sensory organs which have a structure indicating a possible auditory function, and the insect production of sounds. For what other purpose, it was argued, can stridulating organs be used, if not for that of impressing other insects?

Fabre fired two mortars in close proximity to a number of Cicadæ without affecting their songs. He concludes, "If any one were to tell me that the Cicadæ strum on their noisy instruments without giving a thought to the sound produced and for the sheer pleasure of feeling themselves alive, just as we rub our hands in a moment of satisfaction, I should not be greatly shocked." Lutz (1926) is of the same opinion. He writes: "When we can explain the purpose of a man's snoring or the rattling of a Ford car, we may know why this beetle grub rasps. Having slept with a man that snored and having driven a Ford, I believe that the sounds in question are unintentional and quite incidental to the structure of the man and of the machine. May not the same be true of the beetle grub?"

In spite of such incomplete considerations of the subject, there is evidence that certain insects have an auditary sense.

Radl (1905), arguing in part from structure, and in part from experiment, concludes that insects have auditory powers of a primitive and limited kind.

In 1914 Turner and Shwarz tested the auditory powers of various Catacola moths, and found that from 80 to 100 percent of the insects gave positive responses to notes of the pitches C,4 A,4 and B4 from a Galton whistle. In the same year Turner

conducted a number of similar experiments, using the adults of the large Saturnidæ as subjects. A majority of the insects gave positive responses to a wide range of notes sounded on various wind instruments.

In 1925, Kroning tested the auditory sense of bees with a siren. His extensive experiments lead him to the conclusion that, "die Bienen konnten keine Tone wahrend des Fliegens horen, wohl aber in Marsch oder wahrend des Sitzens."

Minnich (1925) brings forth positive evidence in support of the presence of an auditory sense in the larvæ of Vanessa antiopa. His experiments were extensive and complete. He found that these larvæ, when stimulated by sounds, quickly elevated the anterior third of the body. Minnich was very careful to eliminate other possible sources of stimulation. The larvæ of all instars responded; even headless individuals, and parts of the body were capable of response. Minnich also removed the spines; in other cases he loaded them with water droplets or dry flour. Larvæ so treated failed to respond to sounds. The larvæ were tested with a wide range of notes. Mature larvæ responded to notes between C " (1024 vibrations) and C3 (32 vibrations.)

## Original Experiments

The experiments of Minnich suggested to me the possibility of similar reactions in Datana larvæ. These insects are the caterpillars of certain moths. They feed in groups, and give very definite responses to various external stimuli. Air currents, sudden jars, and certain sounds cause each larva to elevate the anterior and posterior thirds of its body; contact with the substratum is maintained by means of the four middle pairs of prolegs. If the stimuli are continued, the insects may throw their heads from side to side.

The larvæ of *D. perspicua* feed on sumac. Just prior to metamorphosis they measure about two inches in length by one-fourth of an inch in width. Their general color is black, but they are marked by several longitudinal yellow stripes. The body is covered with long grayish hairs, so sparsely that the surface of the body is easily visible, but plentiful enough to constitute a

marked anatomical feature. The larvæ of *D. ministra* feed on various species of Cratægus. They resemble the larvæ of *D. perspicua* very closely; the most striking difference is due to the orange color of the prothoracic segment. The responses of the two species are similar, but those of *D. ministra* are not as marked as those of D. perspicua.

Preliminary tests demonstrated that these larvæ give marked responses to only two notes: middle C (512 vibrations) and F sharp above middle C (728 vibrations). The responses were very distinct. The instrument used in making the tests was a closed pipe with a movable plunger. Eleven larvæ were used in each test. The number was purely arbitrary. They were taken from a large cage in which they were kept, and placed on a vertical stick. The tests were made after the caterpillars started to creep. In every case, efforts were made to protect the insects from air blasts from the pipe.

In the critical series of tests, normal larvæ of *D. perspicua* were used only as controls, but a complete set of tests was made with normal larvæ of *D. ministra.*

Attention was chiefly directed toward the rôle of the hairs in the detection of sounds. The methods employed were similar to those used by Minnich in 1925; the hairs were "loaded" with water or shellac. The liquids were sprayed on to the hairs with a nasal "atomizer." As the water had a tendency to run off, it had to be frequently renewed. The shellac was the commercial orange product diluted with an equal volume of ethyl alcohol. Its value lay in its stability; the alcohol soon evaporated, leaving the droplets of shellac fixed on the hairs. These methods of treatment did not seriously injure nor inconvenience the larvæ. Some specimens of *D. perspicua* were bathed with a 2 percent solution of procain. Although this inhibited responses, it was more or less injurious, and several of the insects so treated subsequently died.

Ten trials were made with each group of larvæ; five for each set of vibrations. Four specimens of *D. perspicua* were tested after removing the hairs from their bodies by clipping. Normal insects were also tested with a piano and a mandolin. The results of the experiments are tabulated as follows:

Table I *Datana perspicua*

| Vibration | Water | Shellac | Procain |
|---|---|---|---|
| 512 | — | — | — |
| 728 | slight | — | slight |
| 512 | — | — | — |
| 728 | — | — | — |
| 512 | — | — | — |
| 728 | — | — | — |
| 512 | — | — | — |
| 728 | — | — | — |
| 512 | — | — | — |
| 728 | — | slight | — |
| Control | + | + | + |

Table II *Datana ministra.*

| Vibration | Normal | Water | Shellac |
|---|---|---|---|
| 512 | + | — | — |
| 728 | + | — | — |
| 512 | + | — | — |
| 728 | + | — | — |
| 512 | + | — | — |
| 728 | + | — | — |
| 512 | + | — | — |
| 728 | + | — | — |
| 512 | + | — | — |
| 728 | + | — | — |

## Discussion.

The results of these experiments are startling. In only three were even slight responses elicited after treatment. That the responses are actually due to the sound is evident from the following facts: the response of normal larvæ is given when the insects are protected from all air currents, it can be elicited when the larvæ are several feet away from the source of the sound, it was given to any one of three different musical instruments, and

finally it was elicited when all possibility of vibrations of the substratum were eliminated.

These facts are supported by the results obtained when the hairs were loaded or removed, or when the body surface was anæsthitized.

What is the significance of this peculiar sense? The larvæ give marked responses to only two notes, which, even if they were frequent under natural conditions (which they certainly are not), could hardly be considered of importance to the caterpillars. They are, therefore, not adaptive. It is probable that we are here in the presence of a "secondary" sense, developed as a result of the adaptation of certain organs to more significant stimuli.

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